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Gerd Kaupp

University of Oldenburg, Germany

Thousand waste-free solid-state syntheses from 2 mmol to industrial scale and processes with 100% yield in 26 reaction types

Preparative molecular and ionic solid-state reactions (gas-solid and solid-solid) have been shown to proceed rapidly, with definite completion, at decreased activation energy, and with 100% yield, wasteless and mostly specific. It has been shown at the molecular level that local melting is not required and that anisotropic far-reaching molecular migrations occur within the crystals along crystallographic channels, cleavage planes, and to voids (including amorphous solids) upon chemical reaction (pressure release). Such mechanistic knowledge is at variance with Schmidt's topochemistry hypothesis and despite hundred fold proof also with more than 1000 wasteless 100% yield reactions (directly pure solid product, without solvent requiring workup) all across chemistry in 26 reaction types. Nevertheless, top chemists still long for (local) liquids in molecular solid-state reactions and suggest heating above eutectic temperatures, or also retrogressively they "invent" LAG (liquid assisted grinding) in order to stay with their long disproved hypothesis: they obtain poor yield, incomplete reaction, require catalysts and chromatographic workup, by denying and losing the profits from the solid-state. Unfortunately they often avoid citing the optimal performance of solids' gasification or stoichiometric co-milling of crystals strictly below the lowest eutectic temperature (including deep cooling) without local melting. The most stunning examples out of the 26 reaction types for wasteless synthesis are otherwise not available new products under temperature control. These will be stressed, and relations to packing diagrams will be discussed. Previous syntheses are improved (100%, no catalysts, no moisture, high selectivity or mostly specificity, better use of reagents ($NaHCO_3$ instead of NaOH, all 4 B-H bonds of $NaBH_4$ instead of only one, etc.). The wasteless scaling of solid-state reactions in columns and up to 20 and 100 L ball-mills, and the possibility of continuous industrial production will be presented with actual examples, the equipment discussed. This is environmentally benign, saves the environment, cost, and labor.

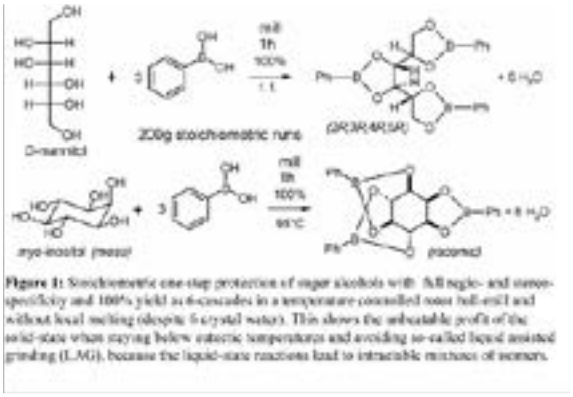

Figure 1: Stoichiometric one-step protection of sugar alcohols with full regio- and stereo-specificity and 100% yield in 6-cascades in a temperature controlled mini ball-mill and without local melting (despite 6 crystal water). This shows the unbeatable profit of the solid-state when staying below eutectic temperatures and avoiding so-called liquid assisted grinding (LAG), because the liquid-state reactions lead to intractable mixtures of isomers.

Biography

Gerd Kaupp has studied Chemistry at the University of Würzburg, Germany and completed Post-doctoral appointments at Ames, Iowa, Lausanne, and Freiburg universities, where he became an Associate Professor. He was a Full Professor at the University of Oldenburg in 1982. He served as a Guest Professor for three international universities. He is now a retired member at the University of Oldenburg and pursues his scientific interests also with consulting. His expertise are in chemical kinetics, laser photochemistry, waste-free benign syntheses and productions, solid-state chemistry, reactive milling, mechanochemistry, atomic force microscopy AFM, scanning near-field optical microscopy SNOM, nanoscratching, nanoindentation, standardization in nanomechanics, and bionics.

gerd.kaupp@uni-oldenburg.de